LAND COVER CHANGE PROBLEM: CREATE ΔNDVI

Advanced Level

Purpose

To create the ΔNDVI images necessary to complete the vegetation change detection unit.

Overview

ΔNDVI image shows the difference (in pixel value) between two NDVI images. The created image is called ΔNDVI because the Greek letter delta notation is used to show *a change*. Using an algebraic transformation formula the ΔNDVI can be created. In the formula below, the C1 represents the older image always and the C2 always represents the newer image.

$$\frac{C1-C2}{1} \times 1$$

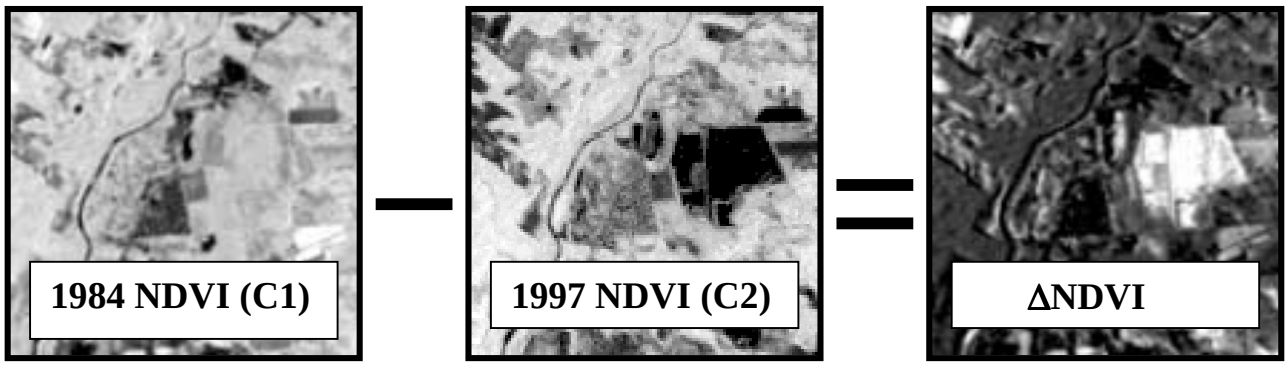


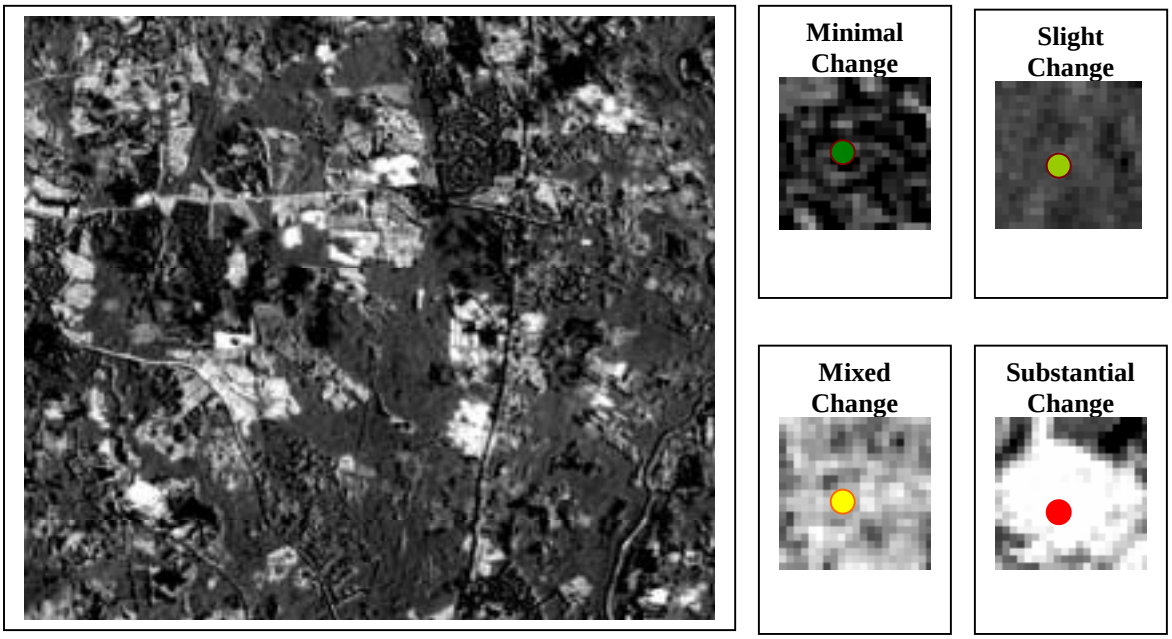
Figure CΔNDVI 1, Visually illustrates the algebraic formula used to create ΔNDVI images

Take one pixel for example. If the C1 84 NDVI value for this pixel is 140 and the C2 97 NDVI value is 0, the ΔNDVI calculated in MultiSpec will be 140.

$$\frac{140 - 0}{1} = 140 \text{ (MultiSpec ΔNDVI pixel value)}$$

Remember when the NDVI image was created using MultiSpec© the NDVI value needed to be multiplied by 255 for display reasons. If the "true" NDVI value is needed divide the pixel value by 255. This is important if you want to compare different NDVI data sets that are available through the Internet. Two excellent sites are: The Kansas Applied Remote Sensing (KARS) Program's Green Report and NASA's Visible Earth site- Vegetation Index page. Most of the NDVI data available through the Internet is not numerical data, but rather an image or map. The image may no longer have the individual pixel values that were used to generate the image.

Tutorial For How To Read A ΔNDVI Image.



In a ΔNDVI image the brighter a pixel the greater the change between the two NDVI images. In the above figure (CΔNDVI 3) there are four visible areas that illustrate different amounts of change in an area. They range from minimal change to substantial change. Note that the areas of low change are dark gray to black while substantial change areas are light gray to white. The ΔNDVI pixel values in each of the sub images are marked by the following dots.

Minimal change	ΔNDVI pixel value 20
Slight Change	ΔNDVI pixel value 31
Mixed Change	ΔNDVI pixel value 84
Substantial Change	ΔNDVI pixel value 158

The following are some general rules to guide the reading of the ΔNDVI image:

If a C1 NDVI pixel value is **High** and the C2 NDVI pixel value is **Low** then the ΔNDVI pixel value will be **High (White).** This pixel value represents **Vegetation Loss** at that specific geographic location between the two satellite data coverage dates.

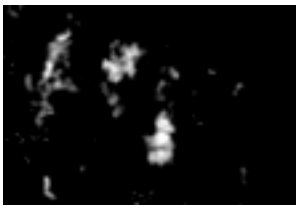
If a C1 NDVI pixel value is **Equal** to the C2 NDVI pixel value then the ΔNDVI pixel value will be **Zero (Black).** This pixel value represents **No Change** in the vegetation at that specific geographic location between the two satellite data coverage dates.

If a C1 NDVI pixel value is **Low** and the C2 NDVI pixel value is **High** then the ΔNDVI pixel value will be **Negative.** This pixel value represents **Vegetation Growth** or a **different type of substantial change** in the vegetation at that specific geographic location between the two satellite data coverage dates. A negative value pixel will be shown with a value of zero. All images are based on a 0-255 grayscale, so zero and negative value pixels will all be black. Below is a MultiSpec text read out for the creation of a ΔNDVI image and the mathematical processes that are used. Therefore the image that results from this calculation will show areas of no change and areas of vegetation growth as zero.

"Reformat 05-14-1999 14:41:03 (MultiSpec7.31.98)
New output image file name: test1.
Transformed channel created.
= 0.000000 + (C1-C2)/(1) * 1.000000
-146 is lowest calculated value.
191 is highest calculated value.
29850 pixels saturated at low end: 0.
0 pixels saturated at high end: 255."

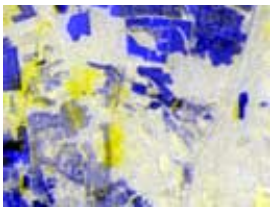
If students wanted to determine the vegetation growth in the same study area over the same time period, all they would have to do is reverse the ΔNDVI image algebra. C1 would now be the newer image, 97 NDVI, and C2 would be the older image in this unit 84 NDVI. (see CΔNDVI 4 compared to the normal ΔNDVI image, CΔNDVI 5.) Now vegetation growth will have the high pixel value and will be white on the ΔNDVI image. Another way of creating the ΔNDVI image is to display both the vegetation growth and loss in one image. (for more details see the description below) This is an image that uses the NDVI images, but instead of transforming the linked NDVI images it displays the two NDVI images as different channels in a color composite image.

Change Images



CΔNDVI 4. Vegetation growth is shown in white by reversing the ΔNDVI image algebra.

CΔNDVI 5. Vegetation loss is shown in the ΔNDVI image by white.



CΔNDVI 6. Vegetation loss is blue, vegetation growth is yellow, and no change is gray.

Time

- 1-2 class periods to review and create the needed images.
- Time out of class can be used for the data analysis.
- Additional time will be necessary for the advanced level to understand how light reflectance works and possibly conduct a radiometer lab using plant reflectance

Level

Intermediate and Advanced

Key Concepts

Communication skills
- Read and understand images produced by others
- Produce images for other to interpret

Technology/Software Mastery
- Use computer software to generate images
- Use computer software to scale images
- Use computer software to interpret images

Computation and Estimation
- Use simple algebraic formulas
- Use, interpret, and compare number

Critical-Response
- Be aware that there may be more than one way to interpret a given set of findings

Skills

Integrating information
Analyzing data
Interpreting data
Using computers

Materials and Tools

MultiSpec software
Landsat images, a current and past images of the same exact area
Color printer
Paper

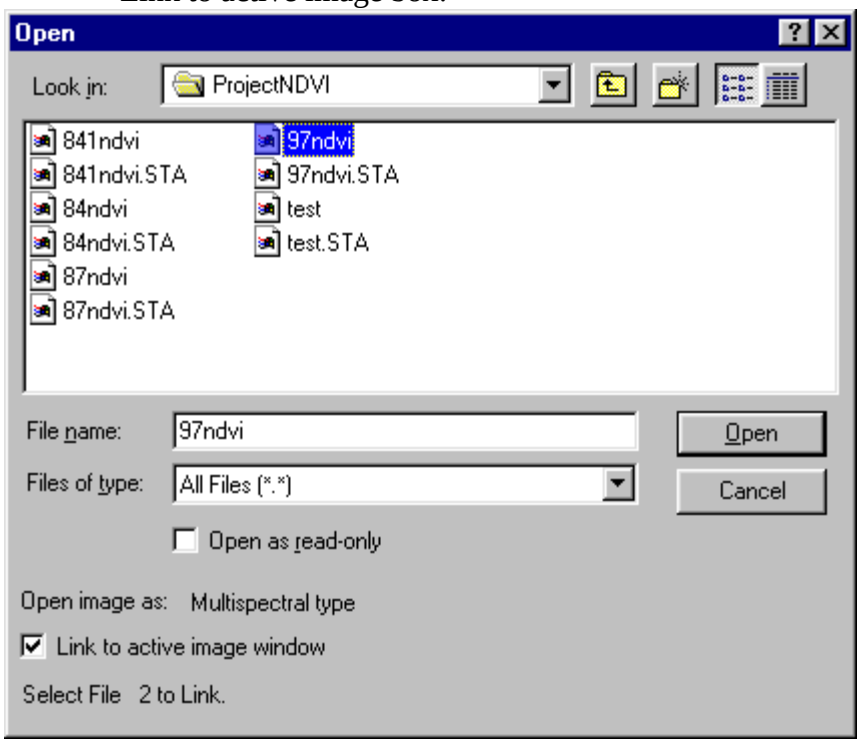
Preparation

- Download the appropriate version of MultiSpec© from their web-site if you do not already have a version.
- Obtain an older Landsat image
- Complete the NDVI calculations on your version of MultiSpec© prior to the lesson to make sure any slight difference in the software don't interfere with the lessons

Normalized Difference Vegetation Index (NDVI) calculation

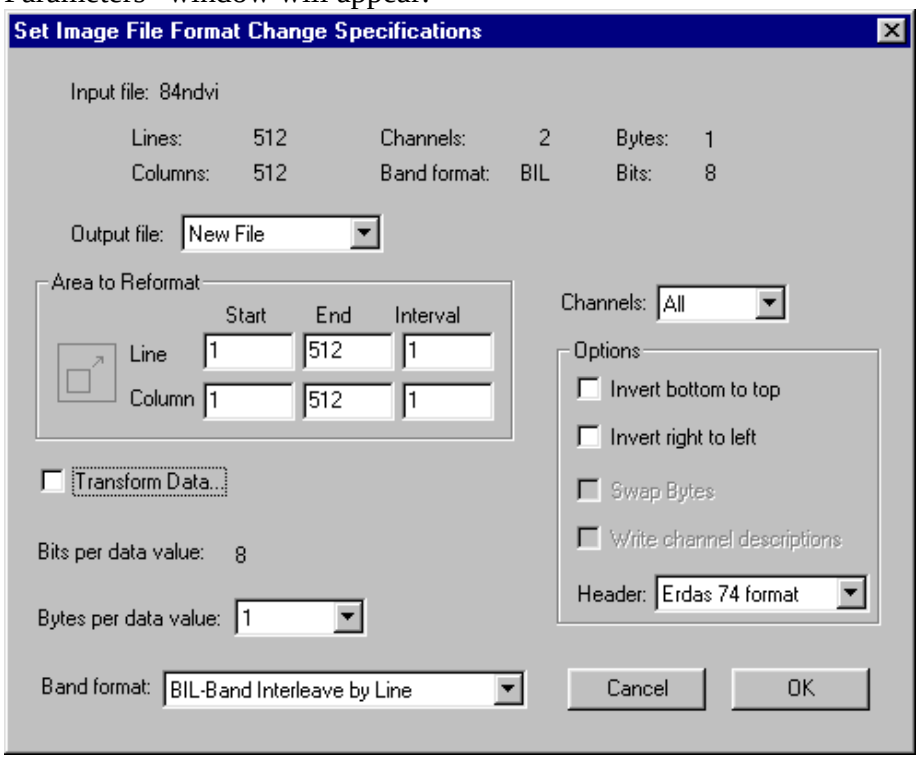
- **Step by step process to calculate ΔNDVI**

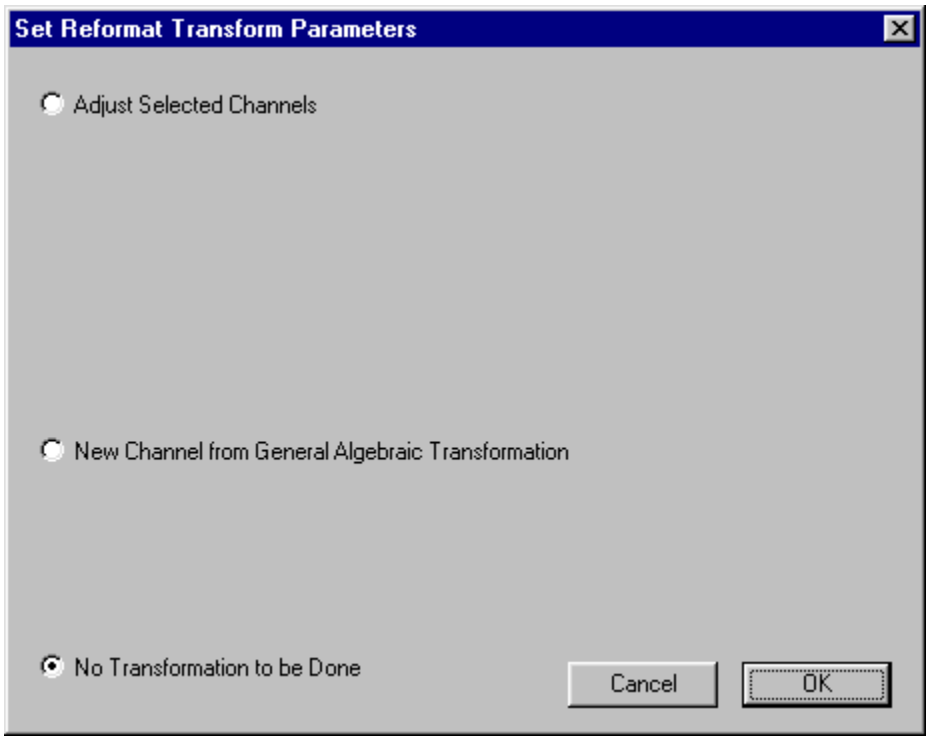
•Open the 84 NDVI image to be converted into a ΔNDVI image.
•Then open the 97 NDVI image to be converted into a ΔNDVI image.
• Link to active image box.



•Select the processor function from the top title bar
•Select the reformat function from the pull down menu
•The Reformatting Utilities window will appear; the default option should be "Change Image File Format." Select the circle if it is not selected and click OK
•The "Set Image File Format Change Specifications" window will appear. Select the "Transform Data…" box. Automatically the "Set Reformat Transform

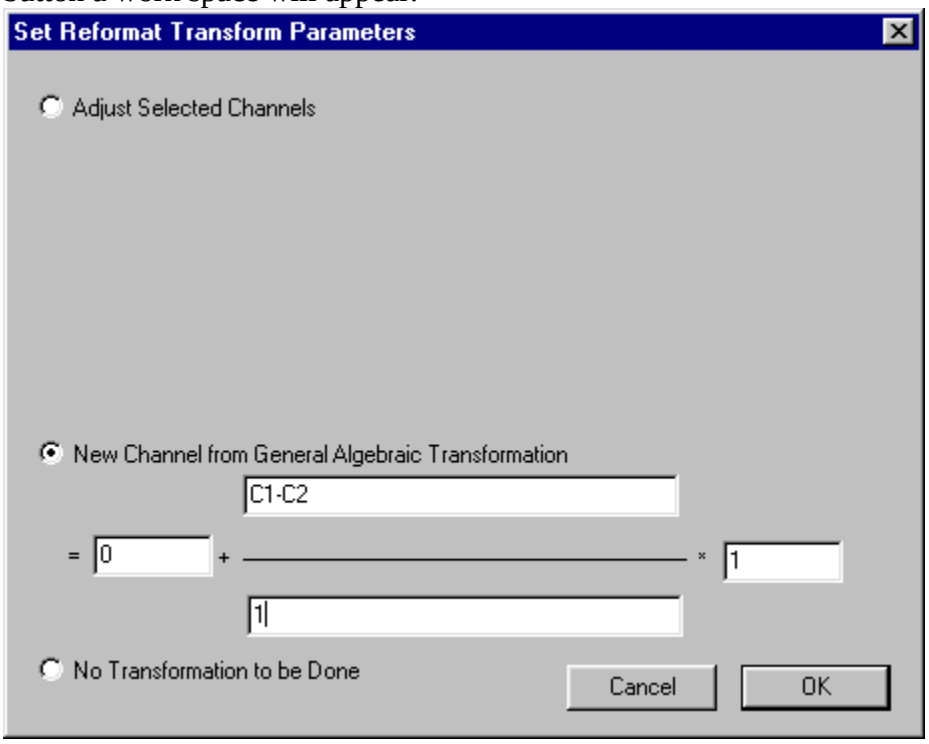
Parameters" window will appear.





- Select the "New Channel from General Algebraic Transformation" button.

•Below the “New Channel from General Algebraic Transformation” button a work space will appear.



•Enter in the formula:

$$0 + \frac{C1 - C2}{1} \times 1$$

•Click OK when it is complete

•Click OK on the “Set Image File Format Change Specifications” window

•Save the image.

•MultiSpec© will now create the image, the percent of completed job should be shown in a Status window.

•The created ΔNDVI image needs to be opened and the “Set Display Specifications for:” should be set to 1-channel color from the pull down menu. Then click OK.

•The “Set Histogram Specifications” window will appear to compute a new histogram, make sure the interval is set to 1 and not 15 for both the lines and columns. Click OK.

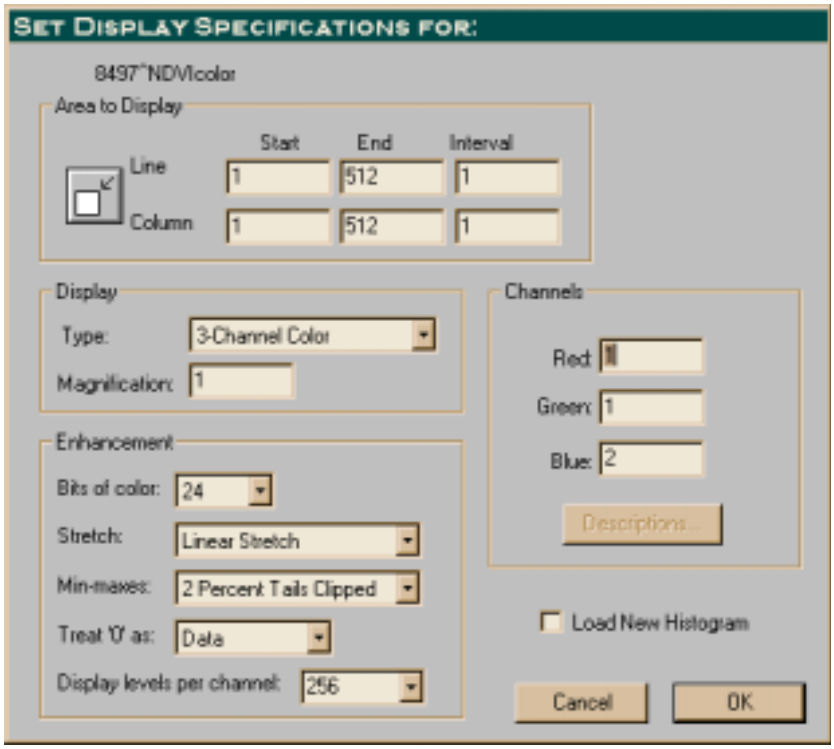
•Once the histogram is created for the first time it will not need to be recreated. The histogram description is recorded in the text window, it can be saved along with the image for future information. The algebraic formula and the highest and lowest calculated values are displayed. Under the file function of the top title bar the function “Save Text Output As…” will allow you to save the information.

VEGETATION GROWTH CALCULATION

Students can also display both the vegetation growth and loss in one image. (open the entire image CΔNDVI6) This is an image that uses the NDVI images, but instead of transforming the linked NDVI images it displays the two NDVI images as different channels in a color composite image. Follow the steps of the ΔNDVI calculation until the fifth step (see below.)

- The "Set Image File Format Change Specifications" window will appear. Select the "Transform Data…"

Do not select the "Transform Data" box, but rather click OK. Title the new image 8497^NDVIcolor. Then open the image and display the image as a 3-channel color type (see CΔNDVI7) with the following channels entered:



Red: 1 (84 NDVI image)
Green: 1 (84 NDVI image)
Blue: 2 (97NDVI image)

Figure CΔNDVI7. A screen shot of the MultiSpec window "set display specifications for:" a color composite ΔNDVI image. Other channel combinations can be used, however the example given best displays the differences between the vegetation growth and loss.